A First Look at X-BADGER data from the Plains Elevated Convection At Night (PECAN) field campaign

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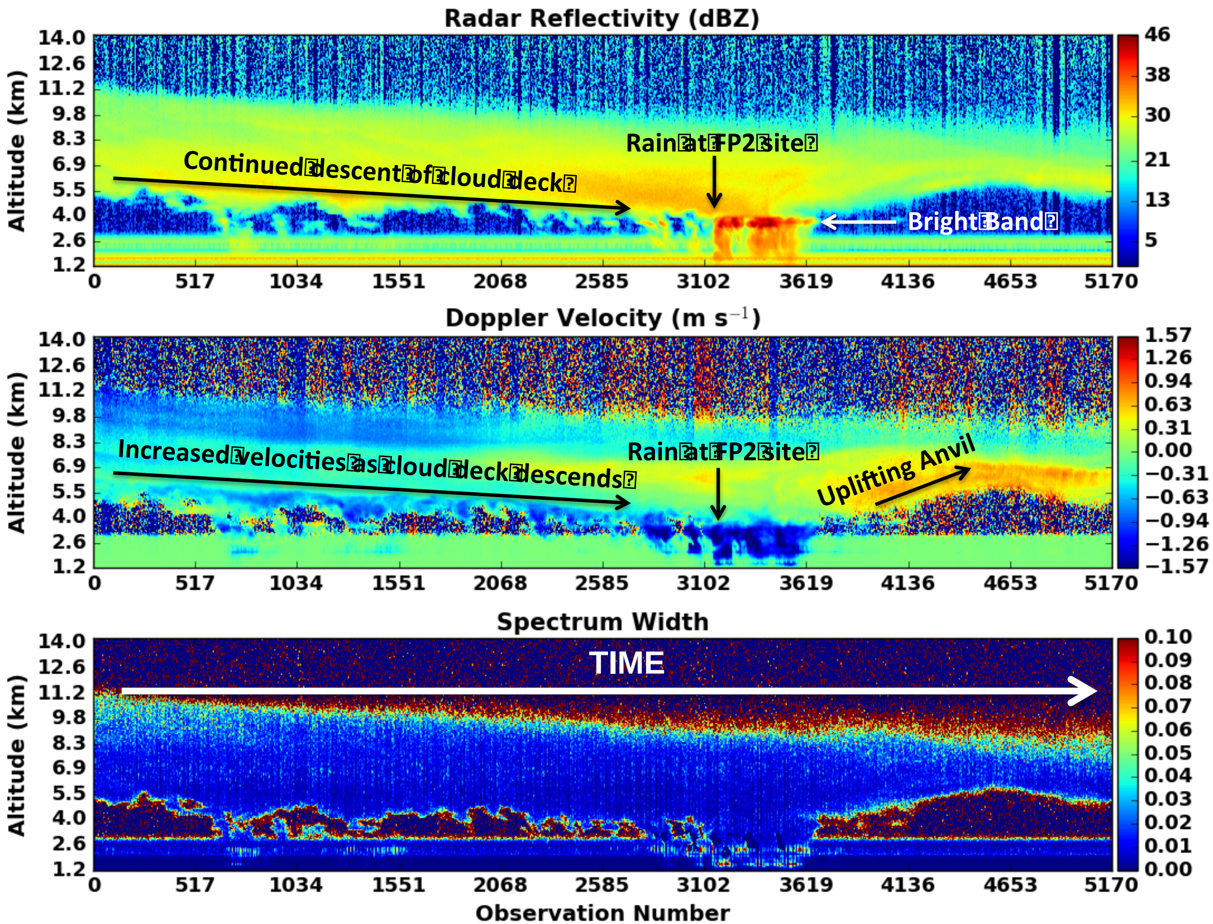

The time-height radar cross-sections shown above are from the 25 June 2015 case during the PECAN field campaign. Multiple instruments including three lidars, profiling radar, interferometer, and tethersonde were located in Greensburg, Kansas from June 1 through July 15, 2015 to study convection, which often occurs at night over the Great Plains region.

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Data Sources: The data shown here are from the X-Band Atmospheric Doppler Ground-based Radar (X-BADGER), which is an upgrade of the ER-2 Doppler (EDOP) radar placed in a mobile research trailer for deployment on field campaigns as well as long-term deployment for ground validation of spaceborne radars. The X-BADGER radar was partially funded by the NASA GSFC IRAD program as well as the GPM mission. Funding for participation in PECAN was provided by Jack Kaye at NASA HQ,

Technical Description of Figures:

Time-Height Radar Profiles: Vertical profiles of radar reflectivity, Doppler velocity, and spectrum width collected with the X-Band Atmospheric Doppler Ground-based Radar (X-BADGER) on 25 June 2015 during the Plains Elevated Convection At Night (PECAN) field campaign. The data were collected over a period of nearly three hours where the continued descent of the cloud deck was observed. Rain finally began to fall out of the cloud base and was reported at the surface of the FP2 site in Greensburg, Kansas. The melting layer is positioned just above the bright band, which is a common feature observed in stratiform precipitation. Approximately fifteen minutes after the rain commenced at the surface, the cloud deck lifted back up and produced small wave-like undulations within the anvil (ice) cloud.

Instruments at FP2 site in Greensburg, KS: Instruments from NASA Goddard (X-BADGER, ALVICE, GLOW), UMBC (Doppler Lidar and MPL), University of Wisconsin (Interferometer), and the Naval Post Graduate School (flux tower, tethersonde, soundings) were co-located at the FP2 site in Greensburg, KS for six weeks during the PECAN field campaign. Of the five fixed observation sites, the FP2 site hosted the most instruments and provided a wealth of data to compare with mobile ground-based facilities as well as airborne instruments that also participated in the largest field campaign to occur in the Great Plains in over 10 years.

Example of Nighttime Convection Observed during PECAN: This is an image of one type of precipitation observed at the FP2 site. This photo was taken looking West from the FP2 site in Greensburg, Kansas on 18 June 2015. The PECAN field campaign was a multi-agency project (NSF, NOAA, NASA, DOE) designed to advance the understanding and increased accuracy of predicting continental, nocturnal, warm-season precipitation. PECAN was focused on nocturnal convection in conditions over the Southern Great Plains including convective initiation (CI), mesoscale convective systems (MCSs), bore/gravity waves, and the nocturnal low-level jet (NLLJ).

Scientific significance, societal relevance, and relationships to future missions: Thunderstorms are most common after sunset across the Southern Great Plains in the summer and much of the resulting precipitation occurs from MCSs. Nocturnal MCSs can produce heavy rainfall and their intensity is often correlated with the strength of the NLLJ. To date, accurate prediction and an in-depth understanding of elevated convection in this environment remains an elusive goal for researchers. Case studies like these allow researchers to study large rain producing events that impact the Great Plains agricultural region in detail.

DSCOVR[ing] EPIC’s Utility for Cloud Retrievals

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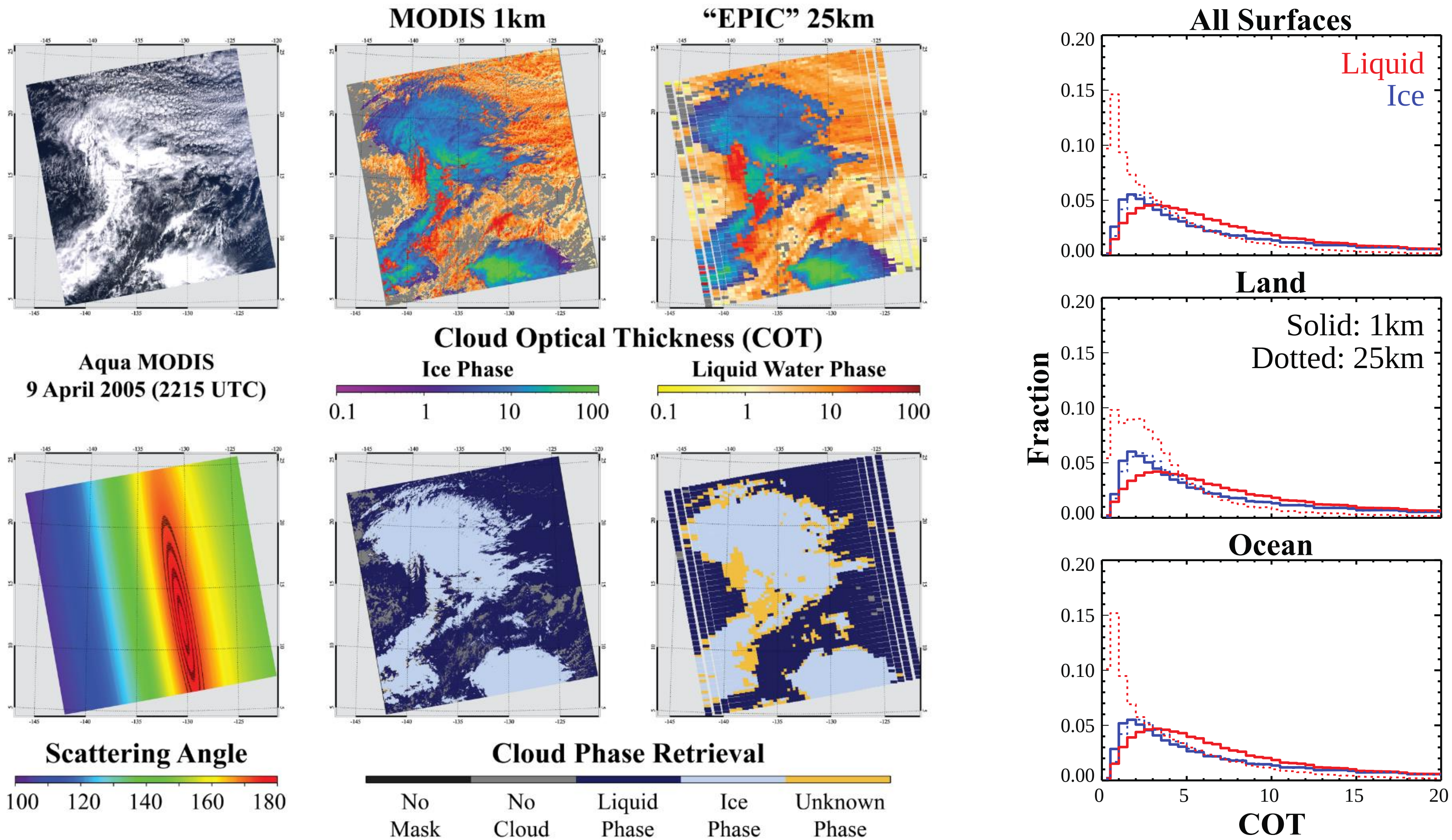

The Earth Polychromatic Imaging Camera (EPIC) offers a smaller spectral channel set and coarser spatial resolution than other space-borne imagers such as MODIS and VIIRS, differences that are expected to impact cloud phase classification skill and the statistics of retrieved cloud properties such as cloud optical thickness (COT). Here, Aqua MODIS data are used to simulate EPIC observations to better understand the expected uncertainties of the NASA EPIC cloud retrievals.

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References:

Meyer, K., Y. Yang, and S. Platnick (2016), Uncertainties in cloud phase and optical thickness retrievals from the Earth Polychromatic Imaging Camera (EPIC), *Atmospheric Measurement Techniques Discussions,* doi:10.5194/amt-2015-326, in review.

Data Sources: NASA MODIS Aqua Data – Collection 6 Level 1b (MYD021KM), and Level 2 cloud mask (MYD35) and cloud optical (MYD06) products, available from the NASA Level 1 and Atmosphere Archive and Distribution System (LAADS) (http://ladsweb.nascom.nasa.gov).

Technical Description of Figures:

Left Images: Left column: True color RGB image acquired by Aqua MODIS on 9 April 2005 at 2215 UTC (top), and observed scattering angle (bottom). Center column: Retrieved cloud optical thickness (COT) and cloud thermodynamic phase from the Aqua MODIS Level 2 cloud product (MYD06) at 1km spatial resolution. Right column: Simulated EPIC retrievals created by aggregating 1 km MODIS reflectance observations to 25 km resolution. EPIC is expected to have less cloud thermodynamic phase discrimination skill, as shown by the increase in undetermined phase clouds (lower right image).

Right Graphs: Histograms of retrieved COT over all surface types (top), land (middle), and ocean (bottom). Red lines indicate liquid phase cloud retrievals and blue lines indicate ice phase retrievals. Solid lines are for the 1 km MYD06 retrievals, and dotted lines are for the 25 km simulated EPIC retrievals. Data are from one month (April 2005) of Aqua MODIS observations having scattering angles near the EPIC scattering angle space (scattering angle between 164^{o} and 176^{o}). EPIC observations are expected to yield COT statistics different from those of imagers having higher spatial resolution and additional spectral channels that provide cloud particle size and phase information.

Scientific significance, societal relevance, and relationships to future missions:

The Deep Space Climate Observatory (DSCOVR) satellite was launched on 11 February 2015, and in June 2015 began making observations of both the Earth and the Sun from its Lissajous orbit about the Earth's L1 Lagrangian point, a gravity neutral position near the Sun-Earth line 1.5 million km from the Earth. The DSCOVR payload includes the Earth Polychromatic Imaging Camera (EPIC) that views the entire sunlit half of the Earth continuously at near backscatter directions (scattering angle between 164^{o} and 176^{o}) at a native spatial resolution of 8 km at nadir. Numerous geophysical products will be derived from EPIC observations at 10 spectral channels ranging from the ultraviolet to the near-infrared (NIR) that are sensitive to various atmospheric and surface components, and can provide information on ozone, aerosol, cloud, and vegetation properties. The NASA EPIC cloud products will include cloud detection, cloud optical thickness (COT), and cloud effective height derived from the oxygen (O_2) A- and B-band observations. The EPIC COT product will be produced with the same core algorithms as those used by the operational MODerate-resolution Imaging Spectroradiometer (MODIS) cloud optical and microphysical property product (MOD06/MYD06 for Terra/Aqua) that provides cloud top pressure, temperature, and height retrievals, as well as simultaneous two-channel retrievals of COT and cloud effective particle radius (CER) and cloud phase retrievals using a variety of spectral tests. However, because the EPIC spectral channel set does not extend to wavelengths longer than the NIR, COT retrievals will be performed using a single-channel approach similar to that of the International Satellite Cloud Climatology Project (ISCCP) and the Multi-angle Imaging SpectroRadiometer (MISR) mission, assuming fixed values for CER. Since COT can be dependent on CER, single-channel COT retrievals are prone to errors larger than those of the two-channel COT-CER retrievals. Cloud thermodynamic phase will be inferred by imposing thresholds on cloud temperature converted from O_2 A-band cloud effective height retrievals, an approach different from MOD06 that relies on measurements in infrared (IR) window and CO_2 absorption channels. Here, we degrade the 1 km Aqua MODIS observations to 25 km spatial resolution to investigate the impacts of EPIC's coarser spatial resolution and limited spectral channel set on retrievals of cloud thermodynamic phase and COT, as well as their aggregated statistics. Results show that EPIC can provide COT retrievals mostly within 10% uncertainty for liquid phase clouds, and within 2% for ice phase clouds.

Suomi NPP satellite observes Alaska's Pavlof volcanic cloud

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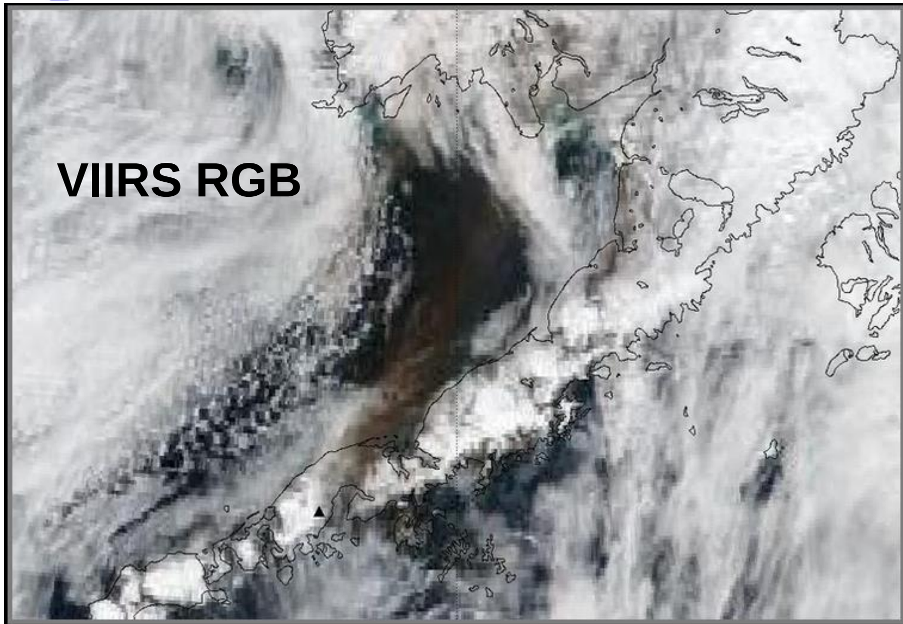

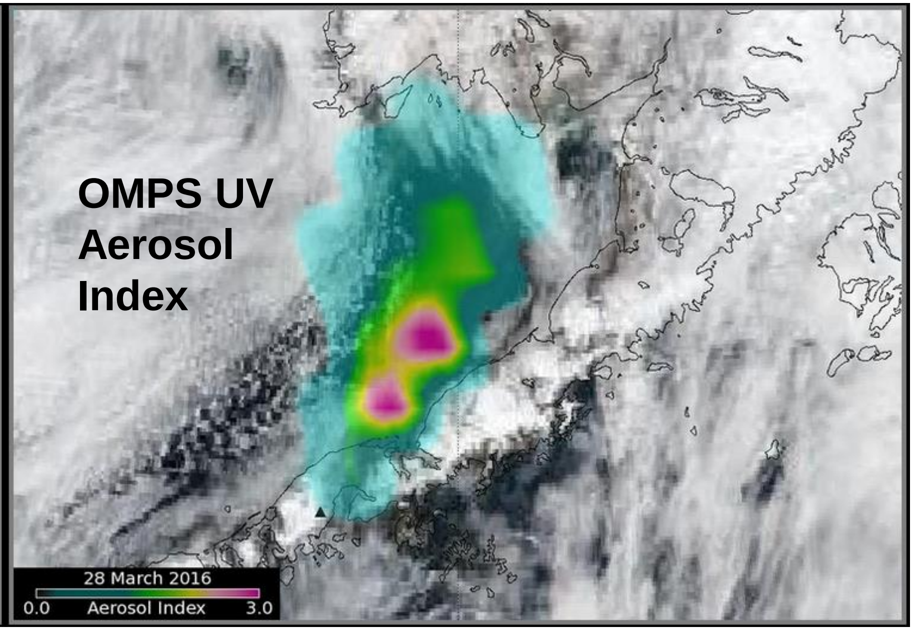

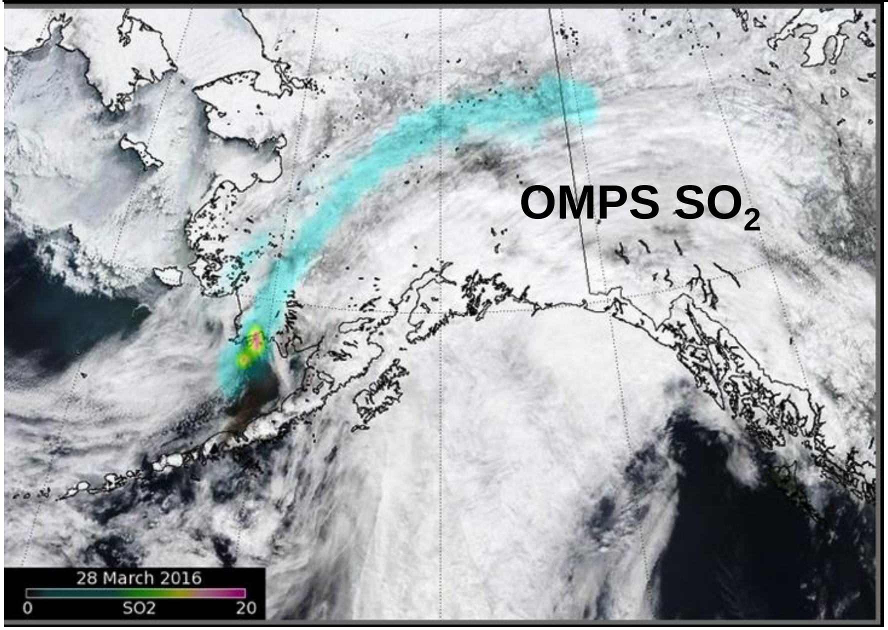

The eruption of Alaska's Pavlof volcano on Sunday March 27 sent dense ash and SO_2 clouds up to 30000 feet (about 9 km) into the atmosphere. USGS AVO declared an aviation code red over the surrounding area. Sensors on Suomi NPP satellite tracked the dense volcanic ash close to the volcano using VIIRS true color imagery (upper left), and with the OMPS UV Aerosol Index (Upper right). OMPS volcanic SO_2 data (lower left) tracked the upper tropospheric part of the cloud moving eastward with jet stream winds over Canada. In high concentration SO_2 is health hazard; it is also useful as a proxy for fine ash undetectable by satellite.

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References: Krotkov N., A., Shahid Habib, and Arlindo da Silva, Eric Hughes, Kai Yang, Kelvin Brentzel, Colin Seftor and Jason Y. Li, David Schneider, Marianne Guffanti, Robert L. Hoffman, Tim Myers, Johanna Tamminen and Seppo Hassinen, Real Time Volcanic Cloud Products and Predictions for Aviation Alerts, Proceedings AIAA conference, June 17-20, 2014, Atlanta GA, http://arc.aiaa.org/doi/abs/10.2514/6.2014-2618

Seftor, C. J., Jaross, G., Kowitt, M., Haken, M., Li, J. and Flynn, L. E.: Postlaunch performance of the Suomi National Polar-orbiting Partnership Ozone Mapping and Profiler Suite (OMPS) nadir sensors, J. Geophys. Res. Atmos., 119(7), 4413–4428, doi:10.1002/2013JD020472, 2014

Data Sources: Global OMPS NRT Data processed by the SNPP Ozone SIPS Team at SSAI, Inc (Led by Dr Colin Seftor).
SNPP VIIRS NRT true color maps processed by NASA LANCE program and available at: https://worldview.earthdata.nasa.gov/

Technical Description of Figures:

Upper Left: VIIRS true color image. The brown-colored plume moving to the northeast of the volcano (black triangle) is visible volcanic ash.

Upper Right: The OMPS Aerosol Index superimposed on the VIIRS true color image. Along with color, the transparency of the plume Is directly related to the magnitude of the cloud; the higher the index, the more opaque the cloud. The capability to detect ash (or smoke and dust), particularly over cloudy areas (at the northern edge of the plume), is enhanced by the use of the Aerosol Index.

Lower Left: The OMPS SO_2 superimposed on the VIIRS true color image. Again, along with color, the transparency of the plume is directly related to the amount of SO_2; the more SO_2 the more opaque the cloud. The displacement of the SO_2 plume is different to that of the ash plume because it is higher in altitude. The SO_2 is often used as a proxy for the presence of fine ash that is below the satellite sensor detection limit.

All 3 images were created from data obtained by the Suomi NPP satellite approximately 20 hours after the onset of the eruption. While no ash has been detected on subsequent days, OMPS continues to track the SO_2 plume in upper troposphere as it moves eastward across Canada.

Scientific significance, societal relevance, and relationships to future missions: The ability to detect and track volcanic ash and SO_2 plumes from solar backscattered UV (BUV) spectrometers, such as OMI on Aura and OMPS on SNPP have proven invaluable in mitigating the effects of volcanic eruptions, including assessing their impact on air quality and delays to air traffic. The data are also provide important input into models used to predict ash and SO_2 trajectories. Following the successful development of the OMI near real-time and real-time systems, OMPS data is now available in both modes. This capability greatly enhances the usefulness of the data, as timely information on the location and trajectory of the ash and SO_2 clouds is critically important for volcanic disaster management. Another OMPS nadir sensor is scheduled for launch on the Joint Polar-Orbiting Satellite System 1 (JPSS 1) satellite early next year. The capability of this upcoming OMPS sensor will be greatly improved, as the Field of View (FOV) will be at much higher resolution (~ 17 km at nadir), allowing for more accurate detection and longer tracking of volcanic plumes.